Global Water Cycle

The global water cycle is resolved at only coarse resolutions, hampering climate models' ability to recreate hydrologic means and extremes that are relevant to local scales. Uncertainties in basic hydrological processes and in the strength of feedback processes, such as clouds and cloud processes, coupling of sea-ice-land, air-sea, and land surface effects result in large ranges in predictions of impacts to the overall climate system.

Water Cycle Study requires:

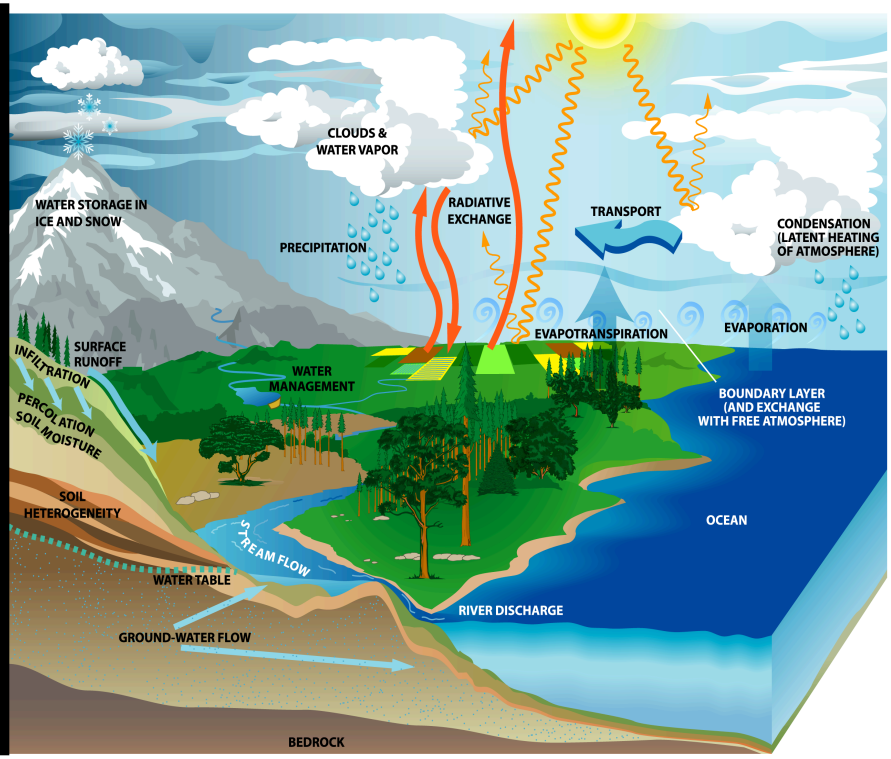
Land-atm and ocean-atm interactions- partitioning of water and energy

Hydrologic states and fluxes: clouds, soil moisture, snow, precipitation, evaporation, etc.

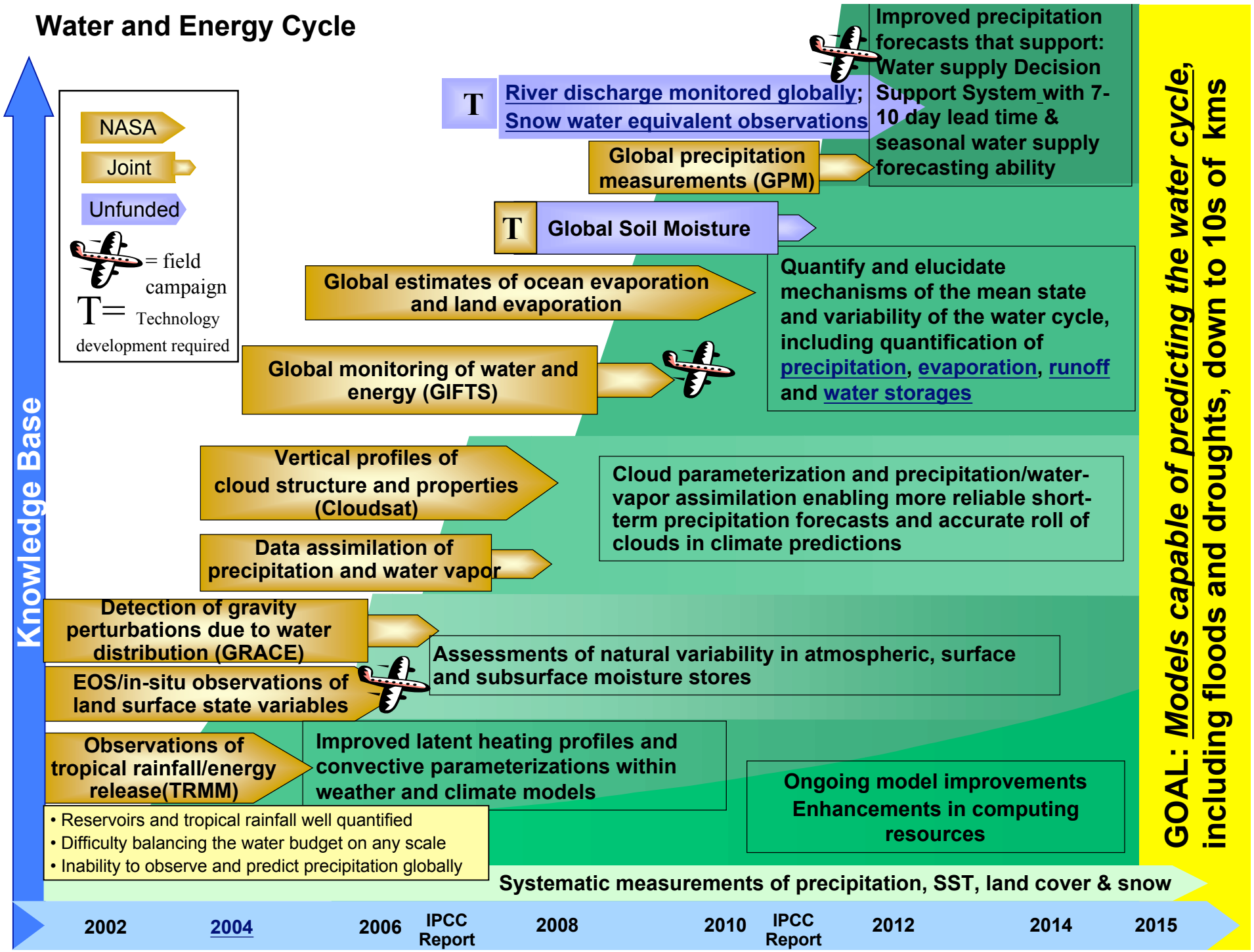
Understanding the water cycle is important for:

Water storage: Drinking Water, Water for Commerce and Energy

Linking Human Activity to Climate Change



NASA has the unique capability to provide global observations of the various components of the water cycle, and then use them to enhance global models and improve predictive capability


Water and Energy Cycle
NASA
Joint
Unfunded
= field campaign
T= Technology development required
T
River discharge monitored globally;
Snow water equivalent observations
Improved precipitation forecasts that support: Water supply Decision Support System with 7-10 day lead time & seasonal water supply forecasting ability
Global precipitation measurements (GPM)
T
Global Soil Moisture
Global estimates of ocean evaporation and land evaporation
Quantify and elucidate mechanisms of the mean state and variability of the water cycle, including quantification of precipitation, evaporation, runoff and water storages
Global monitoring of water and energy (GIFTS)
Vertical profiles of cloud structure and properties (Cloudsat)
Cloud parameterization and precipitation/water-vapor assimilation enabling more reliable short-term precipitation forecasts and accurate roll of clouds in climate predictions
Data assimilation of precipitation and water vapor
Detection of gravity perturbations due to water distribution (GRACE)
Assessments of natural variability in atmospheric, surface and subsurface moisture stores
EOS/in-situ observations of land surface state variables
Observations of tropical rainfall/energy release(TRMM)
Improved latent heating profiles and convective parameterizations within weather and climate models
Ongoing model improvements
Enhancements in computing resources
• Reservoirs and tropical rainfall well quantified
• Difficulty balancing the water budget on any scale
• Inability to observe and predict precipitation globally
Systematic measurements of precipitation, SST, land cover & snow
Knowledge Base
GOAL: Models capable of predicting the water cycle, including floods and droughts, down to 10s of kms
2002
2004
2006
IPCC Report
2008
2010
IPCC Report
2012
2014
2015

Roadmap

Anticipated Progress in Answering the Question

Where we are now	Where we plan to be
The water budget is only balanced over global and large temporal scales to within 20%. Locally, there are large uncertainties in some observations and modeled quantities of the water budget	Water budget known at subcontinental and seasonal scales. Manageable errors in relevant quantities at the catchment scale.
Proxy measurements of land surface quantities (partly based on observations and partly based on models).	Global Observation of Precipitation (over entire diurnal cycle) and important land surface quantities (soil moisture, snow quantity) at mesoscale resolution (order kms).
Limited coverage of satellite measurements of precipitation. Models have large ranges of seasonal predictions of precipitation.	Higher resolution climate models, with improved cloud resolving models, resulting in “useable” seasonal forecasts of precipitation
Uncertainty in causes of variability in the water cycle.	Resolution of the water budget’s mean state and variability. Knowledge of the major influences on its variability

2002 ~ 2015

Roadmap

Anticipated Outcomes of Water Cycle Models

Improved knowledge of the water cycle and the mechanisms underlying its variability would result in improved estimates of soil moisture, snow pack, storage, river flow, etc.